

Year 10 ERC-RMB Annual Report – Student Leadership Council

In this report from the ERC-RMB Student Leadership Council (SLC), we describe progress students have made over this tenth year of our center. First, we revisit the Year 9 SWOT analysis (I) and note the progress made in Year 9 to address the concerns raised in Year 9. This is followed by a series of summaries of the major accomplishments of the Student Association in Year 10. These include Major Student Association Organizational Accomplishments (II), Additional Student Contributions and Achievements (III), and Education & Outreach Activities (IV). The purpose of this report is to describe our major efforts and to provide a representative sample of the student activities that took place in our ERC during Year 10.

I. Review of Year 9 SWOT Analysis

1.1. Address current weaknesses

From the Year 9 SWOT analysis, a number of weaknesses were addressed. In an effort to further enhance student research and overall center progress, the center purchased additional equipment, for example the high resolution SEM-EBSD detector. The students also had the opportunity to attend other universities, such as North Carolina State University, to increase exposure to various equipment as well as receive additional equipment training. A previously cited weakness was interactions with clinicians; therefore, each clinical device group responded by expanding their clinical advisory boards. Industry members and clinicians have continued to attend and contribute to the weekly Trans-ERC meetings. Students were often present during cross-institutional webinars which helped to provide a unique opportunity for students to practice technical presentation skills. Additionally, students were able to interact with members of the IAB and CSAB.

1.2. Address current threats

Many external threats to the ERC-RMB were beyond the scope of the SLC, such as the turnover of new students versus graduating students. The threat of maintaining a connection with alumni was addressed through a series of alumni seminars. ERC-RMB alumni had the opportunity to talk to current students about their experience with the ERC and how they were able to translate those learned skills into their professional careers. The lack of communication addressed in Year 9 continues to improve through weekly Trans-ERC conference calls. Students were invited to participate in weekly conference calls in an effort to stay up-to-date with the ERC research effort. Finally, to address the threat of no clear testing standards in the field of absorbable metals, the relationship with the ASTM working group for standardization of absorbable metals has been evolving. In Year 9, students were given a valuable opportunity to discuss and learn from members of the global research community comprising of academics and industry and regulatory members.

II. Major Student Association Organizational Accomplishments

2.1. ERC RMB Alumni Seminar Series

On April 14, 2017, the SLC launched the first of many Friday ERC-RMB alumni seminar series. The first

seminar was an interactive workshop with ERC-RMB alumni Dr. Danielle Minter entitled “Finding a career, not a job”. Dr. Minter provided insights and vital tips on how to navigate toward a career that greatly matches the applicant’s ability and passion. This talk provided a deeper understanding on the hiring process, employer mindset, how to effectively communicate with recruiters, and the specific job requirements. Danielle’s talk included innumerable information for STEM PhD students who are ready to enter the workforce. Students left the series feeling confident that their deep expertise, transferable skills, and attractive backgrounds have a great impact on the job market today. On May 12, 2017, the second alumni seminar series continued with alumni Andrew Brown. Dr. Brown discussed his guided bone regeneration device, PeriMag, that uses magnesium to aid in the formation of new bone and gingival tissue for craniofacial applications. Dr. Brown also discussed his experience with the commercialization process, including the need for market research and meeting FDA requirements.

SWOT Analysis

The SWOT analysis was conducted using Affinity Diagrams to determine Strengths, Weaknesses, Opportunities, and Threats of the ERC-RMB. The results collected are listed below:

Strengths (10)

- Collaboration between various groups and multiple universities, both domestically and internationally
- Diverse class offerings
- High student involvement in research, SLC, and STEM outreach activities
- Multidisciplinary teams
- Mentoring/leadership provided by administrators, advisors, current students and alumni
- Consistent support from peers
- Hard working students
- Entrepreneurial drive
- STEM educational outreach initiative
- Strong contribution to Mg knowledge-base

Weaknesses (9)

- Lack of events, conferences, and other networking opportunities for students
- Inadequate equipment access, training, and maintenance
- Limited software capabilities and technology support/ training
- Distribution and transparency of funding and project review
- Limited industry connections
- Absence of PhD programs at NC A&T resulting in discontinuity of master’s level research
- Research efforts do not accommodate clinical needs
- Lack of biological knowledge of Mg
- Absence of engineering and regulatory strategy plan for Mg medical applications
- Shifting focus of Mg applications

Opportunities (9)

- Gain funding for
 - o Travel

- Undergraduate research
- Business competitions
- Obtain outside funding
- Further standardization of biodegradable metal testing in ASTM/ISO
- Gain inter-disciplinary research knowledge
- Industry collaboration
- Licensing of technology
- Increase research exposure through conference attendance
- Initiate new degree program in the Engineering department
- Expand biomedical Mg materials research

Threats (9)

- Decreasing interest in biodegradable material within the ERC
- Declining quality of research due to lack of student interest and high student turnover

All ERC- RMB students recognize the vast benefits of being involved with the center. Strong collaboration between SLC organizations at the three RMB universities as well as strong student involvement, fostered through activities such as the student retreat and stem educational outreach activities, were commonly discussed strengths. Strong mentorship provided by administrators, advisors, and alumni throughout the center was another strength mentioned in the analysis. Mentors were committed to helping students develop strong professional skills and increase opportunities for students through the alumni network. Students had the opportunity leverage ERC-RMB resources through travel, conference participation, and extension of current knowledge through research. Events such as the alumni series gave students the opportunity to network with alumni and provided insights on life post-graduation. The potential to license technology developed at the center helped maintain entrepreneurial drive outlined in center goals. Students highlighted this as a strength as it would move us closer to commercialization of biodegradable metals.

With respect to weaknesses and threats, as in previous years, the sustainability of the ERC after the end of NSF funding was mentioned as a potential threat. Additional weaknesses identified included limited equipment and technology access as well as training. This brought up a critical need to strengthen communication between the ERC universities who have access to certain equipment when other universities do not. Many weaknesses and threats centered around declining quality of research within ERC institutions due to high student turnover and diminished funding as well as the limited knowledge as to whether projects are meeting clinical needs. There was much concern about industry receptiveness toward Mg applications. Overall, students within the ERC-RMB were very appreciative and aware of the unique opportunities being a part of the center provides in preparing for our future careers in industry, academia or government.

III. Publication of the 9th issue of student run ERC newsletter

The student organization will soon publish its 9th issue of the ERC-RMB newsletter, where students contributed articles describing research and publications, conferences, awards and accomplishments, and education and outreach. Highlights in the current issue include the Student Retreat and Standardization Workshop, research spotlights through journal articles published over the past year, as well as alumni

profiles where graduated students from the ERC-RMB shared their thoughts on how the Center impacted their lives and where they are now.

IV. Journal Club

The ERC-RMB Journal Club at NC A&T was continued by coordinators Paul McGhee and Amanda Reams through Year 10. Journal Club Director, Amanda Reams presented the first presentation on "How to prepare and present for a successful journal club," where she walked students through her own article review practices. Summer Research Experience Undergraduates (REUs), Young Scholars (YS) and NC A&T bioengineering had the opportunity to present and lead discussions on articles of their choosing. The purpose of the journal club is to promote graduate students to critically evaluate past and current literature in their own area of research. These skills enable one to understand better how a particular field of research has evolved, the current state of research, and what aspects have been inadequately covered in the past. This positions students to better identify their own area of research and ensure the novelty of personal contributions to the advancement of knowledge, leading to higher impact of papers, presentations and proposals.

V. Student Contributions to the ERC

1. Select Accomplishments from Year 9

Students from the ERC-RMB continued to achieve highly over the past year, demonstrating progress in research and entrepreneurship with numerous papers published in peer-reviewed journals, victories in poster competitions, and success at various business presentation competitions. Below are select accomplishments from students from each university.

North Carolina A&T State University

- **Mr. Udhab Adhikari** gave a technical presentation on his publication entitled "Synthesis and Characterization of Alginate-Based Hydrogel Microbeads for Magnesium Release" and "Magnesium and Calcium-Containing Scaffolds for Bone Tissue Regeneration" at the 2016 American Society of Mechanical Engineering International Mechanical Engineering Congress and Exposition in Phoenix, AZ. Udhab was lead author on the publication titled "Magnesium incorporated chitosan-based scaffolds for tissue engineering application" in *Bioactive Materials*. Udhab published book chapter titled "Production of electrospun chitosan for biomedical applications" in *Chitosan Based Biomaterials Volume 1: Fundamentals 2016:211*. Mr. Adhikari was rewarded a travel award and 3rd place in the biomaterials education challenge competition at the Society for Biomaterials (SFB) 2017 Annual Meeting in Minneapolis, MN.
- **Mr. Shalil Khanal** gave a poster presentation entitled "Synthesis and Characterization of Alginate-Based Hydrogel Microbeads for Magnesium Release" and "Magnesium and Calcium-Containing Scaffolds for Bone Tissue Regeneration" at the 2016 American Society of Mechanical Engineering International Mechanical Engineering Congress and Exposition. Shalili was first author on the publication titled "pH-Responsive PLGA Nanoparticle for Controlled Payload Delivery of Diclofenac Sodium" in *Journal of Functional Biomaterials*. Mr. Khanal was rewarded 2016 ASME Track 19 NSF Student Poster Competition Travel for 2016 American Society of Mechanical Engineering International Mechanical Engineering Congress and Exposition in Phoenix, AZ and travel award for the Society of Biomaterials 2017 Annual Meeting in Minneapolis, MN. Shalil was

award 3rd place in the biomaterials education challenge competition at the Society for Biomaterials (SFB) 2017 Annual Meeting in Minneapolis, MN.

- **Ms. Lumei Liu** gave a technical presentation on her publication entitled “Biodegradability and thrombosis assessment of magnesium-based alloys using a microfluidic system” at the Select Biosciences BioEngineering 2017: BioMEMS/Microfluidics, 3D-Bioprinting, Tissue Engineering and Synthetic Biology Conference in Boston, MA.
- **Dr. Paul McGhee** successfully defended his Doctoral Thesis entitled, “”.
- **Mr. Jim Shi** is currently working as a technology manager at Wieland Copper Products, LLC, North Carolina Area.

University of Pittsburgh

- **Jingyao Wu** continued his research on biodegradable tracheal stents. The current focus of his research is to prototype the stents and evaluate the device in relevant animal model. In the past year, he has secured one research grant from McGowan Institute for Regenerative Medicine and Children's Hospital of Pittsburgh of UPMC. He also participated Pitt Innovation Challenge and won \$25K research funding for research translation.
- **Adam Chin**, advised by Dr. Alejandro Almarza, has presented his work as a poster titled “In-Vivo Regenerative Potential of Soft Polymeric Scaffolds in Osteochondral TMJ Defects” at the American Association for Dental Research Conference 2016 in Los Angeles, California. He also gave a podium presentation, “In-Vivo Regenerative Potential of Various Polymeric Scaffolds in Osteochondral TMJ Defects” at the 2016 TMJ Bioengineering Conference in Barcelona, Spain. The same research was also given as an oral presentation at the 2017 International Symposium on Ligaments and Tendons in San Diego, California.
- **Avinash J Patil**, is a PhD student in the Bioengineering Department of the University of Pittsburgh. His PhD work is related to use of Alkylsilane coating to control the corrosion rate of Magnesium. Recently, He published two articles in leading peer-reviewed journals. His first paper has been published in American Chemical Society’s (ACS) journal, “Patil AJ, Jackson OF, Fulton LB, Hong D, Kelleher SA, Desai PA, Chou D, Tan S, Kumta PN, Beniash E "Anticorrosive Self-Assembled Alkylsilane Coatings for Resorbable Magnesium Metal Devices.” ACS Biomaterials Science & Engineering, ACS Biomaterials Science and Engineering, 2017, 3 (4), pp 518–529, DOI: 10.1021/acsbomaterials.6b00585. His second paper has been published in European Cells and Materials (eCM) journal “Avinash J. Patil, Laura B. Fulton, Elia Beniash, "Self-assembled Hybrid Alkylsilane Coating Reduces Mg Corrosion in vivo: a pilot study." European Cells and Materials Vol. 32 Suppl. 6, 2016 (page 49)”. He also presented his work at the 10th World Biomaterials Congress, Montreal, Canada. The title of his poster was “ Patil A, Brown AJ, Zaky S, Sfeir CS and Beniash E (2016). In-vitro study of organosilane coated degradable magnesium dental mesh. Front. Bioeng. Biotechnol. Conference Abstract: 10th World Biomaterials Congress. doi: 10.3389/conf.FBIOE.2016.01.02899”. He and Dr. Beniash has also received the patent based on their coating technology. The tile of his patent is “Beniash, E; Patil, A; “Self-Assembled Organosilane coating for resorbable metal medical devices,” WO 2016/126773 A1, August 11, 2016. They have added two more claims to above patent based on recent work of drug release from Alkylsilane coating and controlling the corrosion of coated Magnesium discs by laser patterning. His lab recently hosted Dr. Tao, a visiting scholar from Wuhan University, China. Avinash and Dr. Tao studied the drug releasing kinetics from Alkylsilane coating. Avinash is planning to graduate in June 2017.

University of Cincinnati

- **Yonghai Zhang** continued his research on smart implant project. The current focus of his research is to use the smart implant concept in the AV fistula application to create a stent that has a controllable degradation. In this year he innovatively used carbon nanotube fiber (CNT) with his smart stent device. CNT fiber is tissue friendly and strong while conductive. He improved the smart stent device and worked with Dr. Prabir Roy-Chaudhury's team on the in vivo testing. Currently Yonghai is also working on his Master's thesis.
- **Chenhao Xu** further researched stent simulation on its corroded model and helped smart implant stent development with Dr. Schulz. He with Dr. Yin fabricated biodegradable stents for Dr. Kumta's group in University of Pittsburgh by using UC's stent design and Dr. Kumta's material. At the same time, he also participated in the water filtration project funded by NSF, an application of carbon nanotube. In addition, The MRS meeting in Boston 2016 and Phoenix 2017 accepted his co-author paper. The paper for MRS in Boston has been published.
- **Pravahan Salunke** continued studying mechanical behavior of magnesium single crystals. He conducted low strain compression tests on single crystal blocks and worked in collaboration with Dr. Sergei Yarmolenko to perform XRD pole figure and EBSD analysis on these blocks at NCAT and NCSU respectively. A manuscript describing the results of these efforts will be submitted to the 'Journal of Materials Research'. Another paper describing the development of the single crystal growth process has been accepted earlier in the journal 'Review of Scientific Instruments'. Mr. Salunke will complete his PhD dissertation titled 'High Purity Magnesium Coatings and Single Crystals for Biomedical Applications' in Spring 2017.
- **Guangqi Zhang** continued the efforts of enlarging the Mg single crystal rods. The newest rod reaches 30 mm in diameter and around 100 mm in length. The hexagonal single crystal rod was also successfully enlarged to a size of 20 mm in diameter and 100 in length. Also, the corrosion behavior of Mg single crystal pellets from different crystallographic orientations were explored. The growth of Mg single crystal rods for bone nail application is also on going. There were also trials in making a stent out of a single crystal rod. As for now, the project is still in process.
- **Tiasha Tarannum** In addition to optimizing the design of Mg AZ31 stents; Ms. Tarannum Tiasha also worked on design and fabrication of the Mg single crystal stent as well as the Zn stent. A paper titled "Expandable Mg-based helical stent assessment using static, dynamic, and porcine *ex vivo* models" has been accepted in the journal "Scientific Reports" in which Tarannum Tiasha was a co-author.
- **Bala Subramanya Pavan Kumar Kandala** As a new student at UC he have joined ERC on September-2016, he started to work on design optimization of the cardiovascular stent. Developed a benchtop flow visualization system has been set up in order to evaluate the performance of photochemical etched helical Mg stents in terms of generating spiral flow with water as the working fluid.
- **Xiaoxian An** continued characterizing the electronspun nanofabric containing polycaprolactone(PCL) fiber and Mg particles, which is provided by Dr. Bhattarai and Udhav in NCAT. As a part of the characterization, hydrogen released during the immersion test were measured by the amperometric hydrogen sensor in Dr. Heineman's lab. I was instructed by Dr. Kuhlman and Dr. Zhao during this time. A manuscript describing our findings is finished and ready to publish. Dr. Bhattarai also provided us conduits rolled from these nanofabric. The conduits were implanted in sciatic nerve injury rats to study Mg's potential in nerve guidance and regeneration. I'm currently working on several rats' behavior tests to evaluate nerve recovery. Meanwhile, I'm helping Guangqi to characterize his Mg pellet samples. And I'm keeping myself updated through the Trans ERC teleconference every week.

2. Participation in National and International Conferences

The ERC-RMB continues to be well represented in domestic and international conferences by its student body. A list of conferences where students presented their work in a platform or poster presentation is shown below.

- 2017 International Symposium on Ligaments and Tendons XVI San Diego, CA
- 2017 Society of Biomaterials Annual Meeting, Minneapolis, MN
- 2017 Select Biosciences BioEngineering: BioMEMS/Microfluidics, 3D-Bioprinting, Tissue Engineering and Synthetic Biology Conference, Boston, MA

3. Outreach Activities

North Carolina A&T State University

During Year 10, NC A&T and SLC graduate students continue to push the STEM-related outreach activities. This includes outreach to local elementary, middle, and high school students. The B.R.A.I.N (Bioengineering Recruiting and Interactive Network) Games was hosted at NC A&T, coordinated by Dr. Matt McCullough and Dr. Vernon Alford. ERC-RMB students helped RETs (Research Experience for Teacher) to run their modules in order to exposed the 22 high school participates to hands-on bioengineering experiments involving thin film technology, nanofiber technology, aspirin mechanism, finite element analysis, etc.

VI. Year 10 SLC Positions and Responsibilities

This section outlines the Year 10 positions and responsibilities within the RMB ERC Student Leadership Council. The seven SLC positions were: President, Thrust Director, Technology Director, Student Retreat Team, Newsletter Team, Education and Outreach Team and Professional Development Team. For each bullet point within a position description, students work together to develop SMART goals (Specific, Measurable, Actionable, Realistic and Time-sensitive) for the following year to measure and monitor progress. A brief (<1 page) summary of activities and progress toward goals will be reported on a quarterly basis.

Presidents (one from each school)

- Facilitate regular meetings with ERC student body at each site (at least monthly)
- Oversee planning of SLC activities and events
- Participate in regular conference calls with the other ERC presidents (every Monday at 2:00pm) for which all students are invited to join
- Work as a liaison between ERC leadership and the SLC
 - Disseminate information from center leadership
 - Ensure Student Day events are aligned with ERC goals
 - Participate in ERC leaders calls to stay up to speed with center updates

Thrust Directors (minimum of one from each Thrust)

- Protocol database management and maintenance
- Provide brief, but comprehensive Thrust updates at Student Day events

- Should include information from all participants within Thrust, including industrial partners if applicable
- Ensure new students become familiar with the people within their Thrust and the technical capabilities of each school as soon as they join the ERC
- For Thrust 4: Arrange for surgery observations or interaction with clinicians for students working on relevant projects

Technology Directors

- Work with Dr. Yarmolenko and ERC-RMB web development team to maintain updates on the website
 - Work with other teams to gather student information to be used to keep student portion of website up to date
 - Provide material database maintenance and feedback to administrators
 - Establish guidelines for the use and uploading of documents to the MDB
- Maintain social media presence on Facebook and LinkedIn, posting future events, relevant articles, and photos regarding SLC and general ERC-RMB events

Student Retreat (Student Day) Team

- Planning of Student Retreats and meetings in collaboration with the Presidents
 - Identifying the site of the retreat e.g. an ERC school, a conference or alternate site
 - Generate agendas, including social activities
 - Work with the Professional Development team to contact and make arrangements with desired speakers
 - Keep track of expenditures for Student Retreats
- Reporting of Student Retreats in collaboration with the Presidents
 - Assist in analyzing SWOT data to determine goals for following year and to improve future Student Retreats
 - Refine current sessions and develop new ones to improve Student Retreats

Newsletter Team (Secretaries)

- Article editing and writing
 - Communicating with other teams to ensure that articles for ERC-RMB events have been written in a timely manner
- Determining new sections that could be included in the newsletter and implementing them
- Formatting of newsletter
- Work with Technology Directors to share photos and articles for website and social media outlets

Education & Outreach Team

- Plan and share E&O events among students at all universities
- Provide periodic updates on E&O events to be used for ERC-RMB website and social media
- Write newsletter articles on E&O events

Professional Development Team

- Work with leadership to establish internship programs and career resources for students
 - Contact and work directly with Dr. Seoane (NCAT) and Dr. Borovetz (Pitt)
 - Disseminate information on upcoming professional development opportunities to ERC students
- Establish ways in which current ERC students and alumni can maintain communication, such as with LinkedIn group
- Collaborate with Student Retreat Team and Presidents to plan informative workshops and speakers relevant to professional development
- Establish and maintain a database of conferences, professional development events attended by students at each school

Journal Club Directors

- Facilitate bi-weekly or monthly meetings with ERC-RMB student body at each site and periodic Trans-ERC journal meetings
- Select speakers to present an article related to their research
- Send out presenter's article to club attendee no later than a week before the meeting
- The selection of speakers should rotate through each of the ERC-RMB thrusts